

# HARDIER SPINELESS CACTUS

Present Commercial Varieties of Prickly Pear Suited to Very Limited Range—  
Selection of Favorable Variations in Native Species Gives Promise of  
Providing Forms That Will Stand Zero Temperature.

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IN a consideration of spineless prickly pear culture on anything like a comprehensive scale, the first and most important necessity consists in making it applicable to a greater territory. At present, the crop is not to be considered in our southwest, except in California and the least frosty portions of Arizona. It is not to be thought of in New Mexico, nor Texas, except in the southernmost extremity; and the indications are that it can be only imperfectly grown on our gulf coast, and is adapted to only a portion of the coastal region of Florida. So far as the mainland of the United States is concerned, then, there is only a comparatively small territory to which the present spineless varieties are applicable.

The limiting factor is one of temperature, the plants not being able to endure temperatures any lower than the orange. Just where the danger point lies is as difficult to state as it is with any other crop; because contributing factors are numerous, poorly understood, and exceedingly influential in varying the effect of given temperatures.

During the January freeze of 1913, in California, the Department's collection was subjected to a temperature of 13° F. for at most but a few hours; only two or three spineless species escaped injury, the majority being very severely hurt and all young plants as a rule killed. In previous years, the same collection has been severely injured by temperatures of 20° of longer duration. During the freeze of 1913, on the other hand, one of the Department's coöperators at Lakeside, California, had an actual record of 8° F. in one of his cactus plantings, and the injury done was negligible. In one of the

Department's plantings at San Antonio, Texas, a temperature of 20° F. with sub-freezing weather for 24 hours has always proved fatal to all of the conventional spineless species now so abundant in California, and so widely advertised in the South and Southwest generally.

From this brief survey, it will be readily seen that exact temperatures give us no more information with this crop than with any other. The data of value here as with other crops is gained from actual growing records. The region in which the plants succeed is the one to which the crop is adapted. The various varieties have now been tested over a wide enough territory so that we are able with certainty to limit the crop as at present constituted to the region suggested above.

## BASIS FOR IMPROVEMENT.

At the present time, there is in this country a considerable wealth of material to work with. There are four or five good botanical species of rapid-growing spineless prickly pears. These in turn can be divided still further into what would in other groups be recognized as at least twice that number of horticultural varieties. Besides these 10 or more forms already spineless, there are not far from 100 species of all grades of spininess having qualities which place them in the economic class and make them of economic possibility. But since we have in mind mainly the production of spineless forms suitable for colder territory, species applicable to our use become very much restricted in numbers. For reasons which will become apparent later, our hopes center

in a few species outside of the known spineless forms.

Since all of the conventional spineless prickly pears are tender to frost conditions in this country, there is no hope of making decided improvement in this group of plants within itself. Dependence must necessarily be placed in the native species of the United States, which are best adapted for this purpose. In the selection of our plants, we must keep constantly in mind three requisites; the first and foremost being tonnage of production; second, resistance to cold; and third, spinelessness. Since the crop is of low nutritive value, comparing with sorghum hay at a ratio of 10 to 1 (*i. e.*, 10 pounds of green succulent pear equal in feeding value 1 pound of good sorghum hay), it is absolutely essential that a comparatively large tonnage be secured in order to make it worth while to grow the crop. Our task is so to increase resistance to cold that the crop may become applicable to a greater territory. But while doing these two things, it is imperative that we maintain the spineless character. However, we may allow our notions of spinelessness to become rather lax, for cattle are able to thrive on quite rough feed; and absolute spinelessness has never been attained in any of the species thus far. All of the so-called spineless species bear a few of the annoying spicules; and the majority of them, some spines as well. Nevertheless, the so-called spineless species of today are sufficiently smooth for cattle to eat with impunity; and we can, therefore, adopt the average of them as our standard of spinelessness very safely.

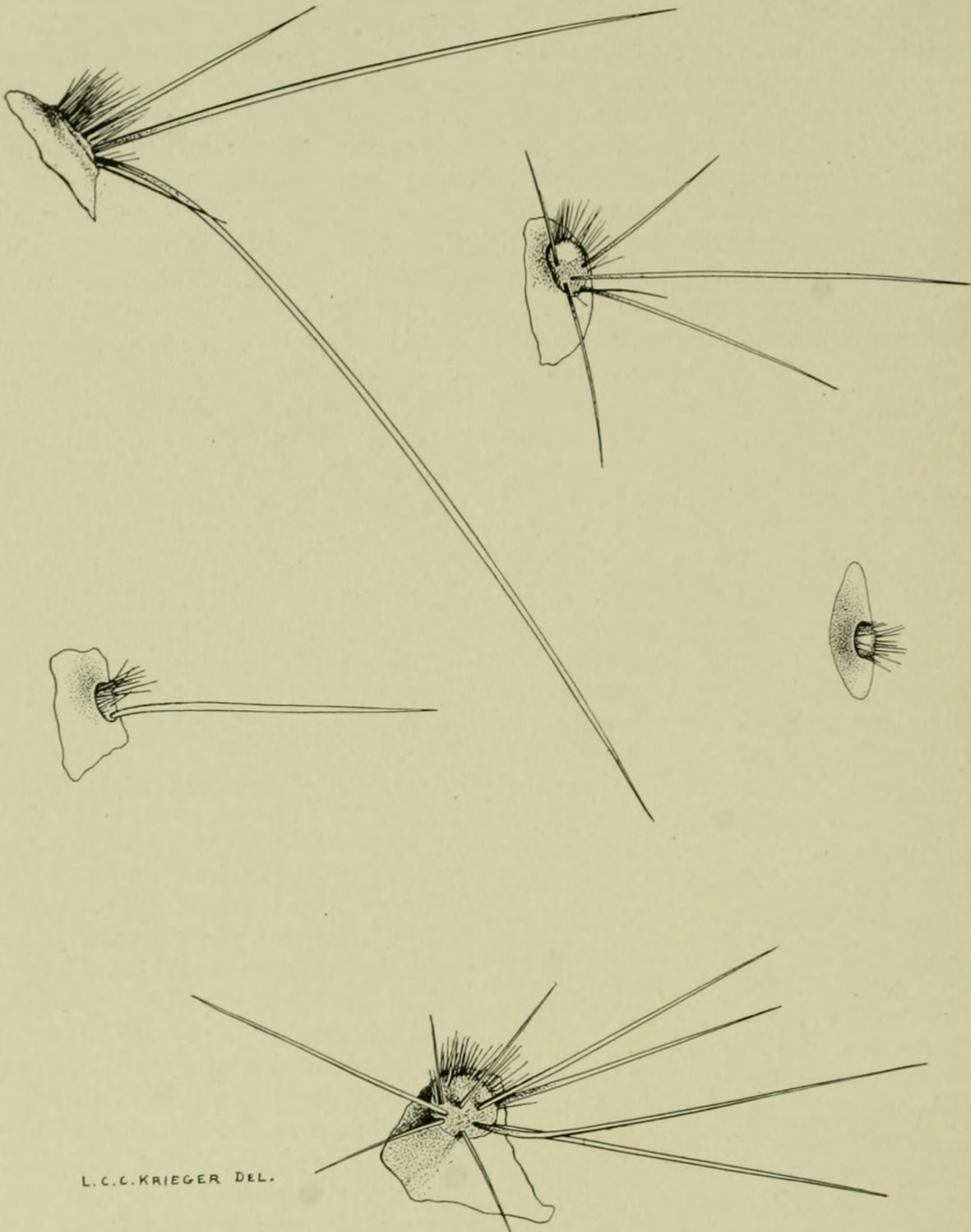
The conventional spineless forms meet the requirements not only of spinelessness, but a number of them are sufficiently productive as well. Our problem, therefore, is very much simplified in that we need to increase hardiness only, while maintaining, of course, the other two characteristics. As stated above, there is practically no hope of being able to increase the hardiness of these forms within themselves; for they are all tender. It is, therefore, necessary to look for characters outside

of the present spineless species which can be bred into them. The native hardy species of this country—and for obvious reasons it is to the species of this country that we are obliged to turn for hardy characteristics—are for the most part spiny, and on the whole unpromising. They furnish stock food after being singed, but that does not concern us in this study. Many of the species, however, are very variable in spination; and some spiny hardy natives of Texas have individuals almost if not quite destitute of spines; although they all have plenty of the spicules. The latter, however, are also variable; and individual plants may be found with comparatively few of them present. These are the main characteristics which appear to bear upon our problem of increasing the hardiness of these plants; and it has been with such ideas in mind that the work along this line has been conducted.

#### NATIVE SPECIES EXAMINED.

For the past seven years, a constant watchfulness has been exercised to discover the least spiny of the hardy native species; and the attempt has been not to go too far north for these, but to work with the expectation of pushing the crop, say 200 miles farther north, or in other words, to increase hardiness so that the species will stand, we will say, temperatures of 0° F., or possibly a little lower. It has been considered that an attempt to make too great leaps will inevitably lead to disaster, for the species which are hardy to temperatures of 20° below zero are very unpromising both from the nature of their spines, and from their small stature and slow growth. Our ambition has been rather to produce economic spineless species which will thrive in the present pear region of Texas, say as far north as Austin.

Thus far, expectations have in a measure been fulfilled; and three, possibly four or five, species have been selected which are very promising for further breeding purposes. It is rather remarkable that in these selections, field judgment has not always proven reliable; for plants have not always

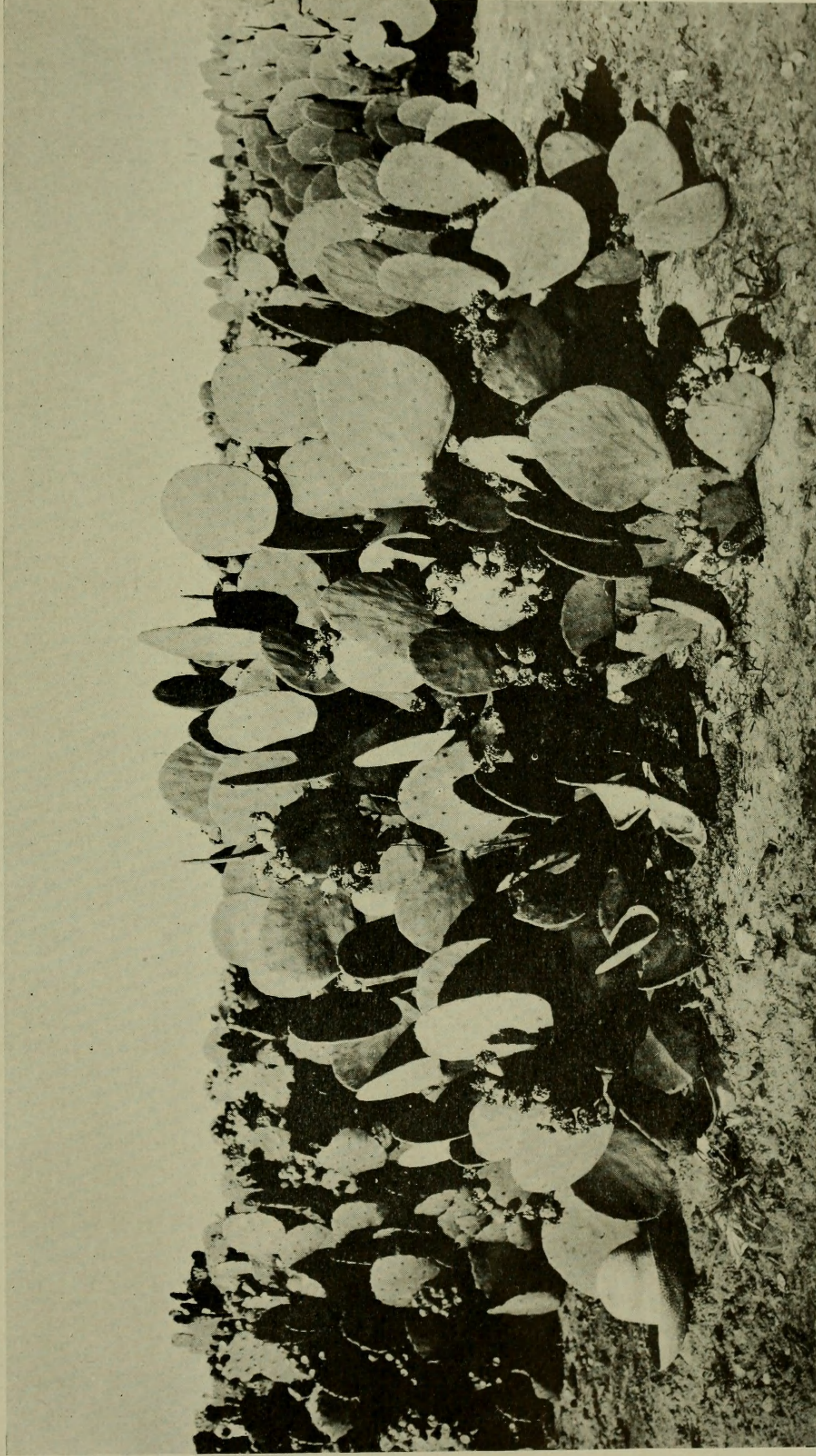


#### A WIDE RANGE OF VARIATION

A single pulvinus or cushion of spines from each of five varieties of the prickly pear known to botanists as *Opuntia cacanapa*. The long stiff spines vary in number from 0 to 9. It is not difficult to breed most of the spines out of a variety of prickly pear, but it is much more difficult to eliminate the short, tender spicules which cluster around the base of the spine. Most varieties of "spineless cactus" lack spines but still possess a certain number of spicules; this makes them unpleasant to handle but does not absolutely prevent their use as stock feed, since cattle can handle quite rough feed. Illustrations about one-half natural size. (Fig. 15.)

turned out as well as was expected when they were found. Forms of *Opuntia dillei* were once looked upon as promising; but these have long since been proved of no value—at least so far as three or four forms which we have carefully studied are concerned. In

all of these investigations, the desire has been to secure as a starting point for hybridizations the least spiny plants possible consistent with a reasonable expectation of rapid growth. Out of 3000 forms collected only three, with a possible additional two more, are now



#### PROMISING MATERIAL FOR BREEDING

A practically spineless selection of *Opuntia cacanapa* under cultivation at San Antonio, Texas. The plant is four years old from cuttings, and probably not more than three or four spines will be found on the entire plant. This does not mean that spicules are absent, but their presence is not a fatal defect. The species here shown is a native of Southern Texas and a product of selections by the U. S. Department of Agriculture. Numerous varieties are recognized—in fact, the great range of variation (see Fig. 15) in this species is one of the characteristics which makes it most suitable for the attention of the genetist. (Fig. 16.)



#### A COMPLETELY SPINELESS CULTIVATION

Two-year-old plant of *Opuntia subarmata*, a native of Southern Texas and a result of selection in the work of the U. S. Department of Agriculture to produce hardier varieties of spineless cactus for the Southwest. This plant is perfectly spineless, and the number of spicules is not large. This species will stand from 12° to 20° more cold than the commercial varieties of spineless cactus at present known, which are too tender to be grown except under most favorable conditions. (Fig. 17.)

considered at all promising for this purpose. These, we think, belong to as many botanical species.<sup>1</sup>

As stated in a previous publication, some of the species which are fed very successfully in southern Texas are not adapted at all for our purpose because of being persistently spiny. However, in one general region of Texas the native species normally are very variable in spination; and occasionally plants are met with which are very nearly or even quite destitute of spines. The greatest variation the writer has ever known in a single species of prickly pear is exhibited in *Opuntia cacanapa*. This species as conceived when it was first described has one erect white or bone-like spine to each areole or cushion of spines. Further study has proven that its spines may be three or even six in number; and one plant of "cacanapa" has been found, which is nearly destitute of spines, and has even the number of spicules somewhat reduced. Vegetatively propagated selec-

tions from this are now entirely destitute of spines. The latter form is described beyond; but it will be instructive at this point to glance briefly at some of the diversities which are encountered in this species—or no doubt some one will say "group of species;" for we have here either one species, or we have more than one. The important fact, though, from our standpoint, is that one form is nearly or quite spineless, and remains so when propagated vegetatively.

#### MUCH VARIATION FOUND.

When this species or this group of species is studied broadly, one finds greater differences than constitute good species elsewhere in the genus. There is, however, a scarcely definable something that links the different forms together unmistakably. And this something is a quality that does not require a trained botanist to recognize. Indeed, the Mexican peon will point to all these forms with unerring certainty as "caca-

<sup>1</sup> A peculiar condition is found in one California species wherein the variation occurs, not between the individual plants but upon the joints of a single plant. This has not yet yielded to selective influences.

napa." It makes no difference whether it is the form with the single erect spine, the smooth, or the exceedingly spiny one that he is dealing with. Sometimes he will apply a qualifying adjective to designate the different forms. But they are all "cacanapa" to him.

The artist has brought out the difference in fig. 15, so that little further need be said. It may be added, however, that the differences in what we consider varieties in this species are greater than those used to distinguish species in other groups. The differences are not confined to spines alone; in varying degrees, they are those of the entire range of characters used for taxonomic purposes. The species is typically glaucous; but many individuals are yellowish-green, and it is in the yellowish-green varieties that the greatest spination occurs. Typically, the joints are subcircular; but there is little regularity in shape, except in so far as the individual or groups of individual plants are concerned. There is, however, a striking similarity in the fruit of the entire group of varieties, a similarity possessed by this and one or two other species.

In the illustrations are shown differences in spination mainly, that being the most striking variation. With these spiny forms is to be compared the spineless, but not spiculeless, variety shown in fig. 15. There are but few species in southern Texas more spiny than *Op. cacanapa*; and likewise, no native species with fewer spines. There are other species which from some standpoints are more promising for breeding purposes in this pear region; but their constant spininess renders them unfit. This is simply another instance of the oft-repeated principle that those plants and those only are favorable objects for selection which have great range of variation.

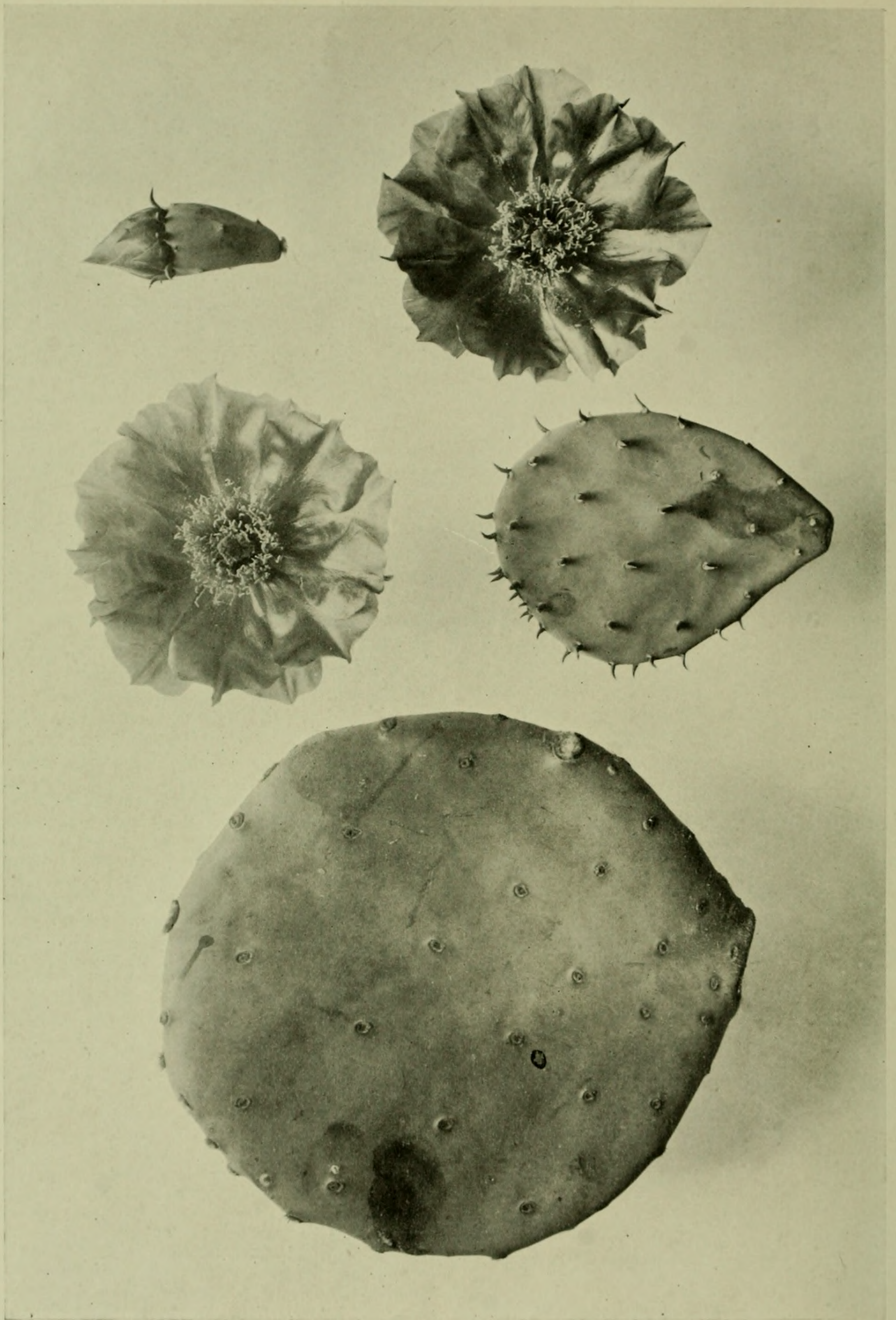
Our experience with these plants leads us to think that there are no species more promising for increasing the hardness of the spineless prickly pears than *Opuntia cacanapa*, *Op. ellisiana*, and *Op. subarmata*. To these may be added *Opuntia bentonii*; two or three other varieties rather closely related to

*Op. subarmata*; and one apparently entirely without spines, but having spicules in about the same proportion as typical *Op. bentonii*. At present this is thought to be a variant of *Op. bentonii*. Since breeding work with these species is already well under way, it is desirable to have the forms we are using characterized and fixed in type as accurately as may be for purposes of later comparison as well as to record the facts of the selection of such rare plants among an abundance of very spiny species on the one hand, and on the other, very spiny individuals of the same species. It is very probable that the conventional tender spineless forms owe their origin to much the same process of selection as here employed; but it has continued through many generations of time. Some of it has been conscious and some unconscious; some of it American and some European.

#### OPUNTIA CACANAPA Griffiths.

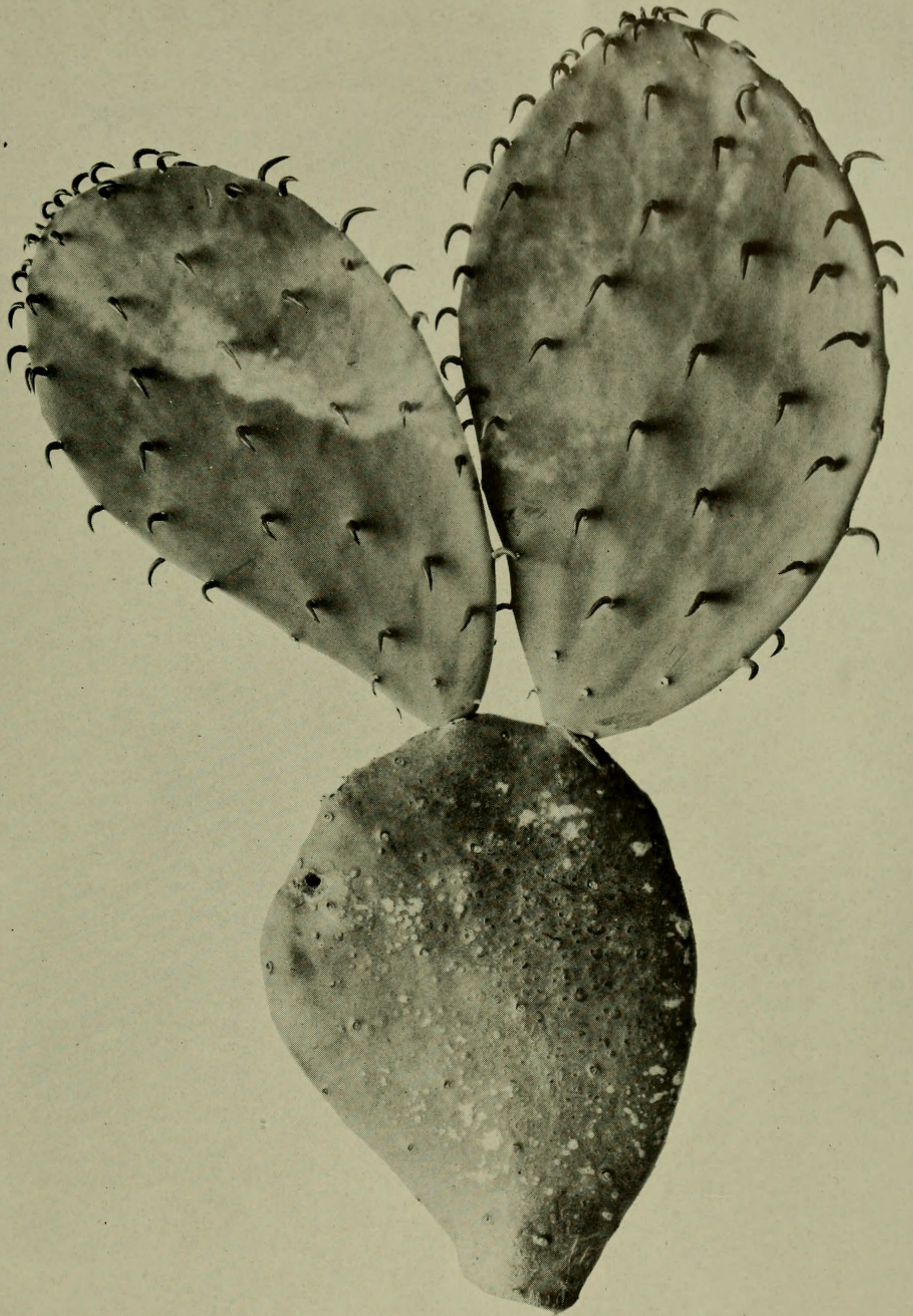
An erect or ascending, spreading, open-branched species, reaching a height of 1½-2 m., and a spread of branch of 1½-2¼ m.; joints subcircular, about 16 x 18 cm., glaucous, gray-green, when mature, but turning more yellowish by loss of bloom in age; areoles white when young, turning tawny at maturity, and dirty gray in age, subcircular to broadly obovate, 3 mm. long on edge, smaller on sides of joints, becoming subcircular and somewhat larger when old; leaves long, prominent, oval in section, arising from an abrupt small tubercle, 1 mm. high, 16-17 mm. long, subulate, cuspidate, broadly arched backwards; spicules light yellow, unequal, scattered through entire edge of areole, but more prominent above, with the wool in the center and 1 or 2 mm. high on edges of joints, 3-5 mm. long, but much shorter on sides; spines almost absent; only an occasional one in a rare areole 1 or 2 cm. long, seldom seen; flowers deep yellow, about 7 cm. in diameter when open, and petals 5 cm. long, filaments yellow above, greenish tinged at base, style white, stigma white, 8-parted with long linear divisions; fruit red throughout, small, obovate to subglobose, 3-4½ cm. in diameter with comparatively thick rind.

This variety of *Opuntia cacanapa* is of medium rapid growth, somewhat slower than *Opuntia lindheimeri* of the San Antonio region. In structure it is somewhat more fibrous, and the joints are not so thick. This is characteristic of all of the varieties of this species.



#### DETAILS OF A VALUABLE PRICKLY PEAR

Old and young joints, flowers and bud of *Opuntia subarmata*, an entire plant of which was shown in Fig. 17. This plant is a perfectly spineless one, with few spicules, and was selected from a mass of spiny plants of the same kind in the Devil's River region of Texas. It is now being propagated by cuttings, so that it is not likely to revert to the ancestral, spiny condition of the species. The old joint, at the bottom, shows the spineless condition; the young joint, above, shows the rudimentary leaves, which drop off in a few weeks. It will be remembered that the prickly pear plant consists merely of stems, which are flattened out; the leaves were long ago reduced, in the process of evolution, to slight fleshy protuberances such as here shown, which are soon lost. (Fig. 18.)



#### A DESIRABLE FORM, READY TO HAND

The Mexican population of Southern Texas is believed to have produced this admirable spineless prickly pear, *Opuntia ellisiana*, by conscious or unconscious selection of the hardy but usually spiny native species. Here the spines have not only been abolished, but the spicules have been almost wholly eliminated, as well. In nearly all other spineless forms, the spicules are more numerous. The fleshy hooks on the young joints at the top are rudimentary leaves, which will soon drop off. Professor J. C. Ellis of the University of Texas first discovered this form among the Mexicans in the outskirts of Corpus Christi, Texas. It is hoped that the hardiness of the form here shown, which will endure a temperature of close to zero, Fahrenheit, can be combined with the valuable commercial qualities of other parents, and an ideal spineless cactus produced for the Southwestern States. (Fig. 19.)



The plants are upright in habit, and while not compact in growth, they are stout and firm and never lax, sprangly or ungainly in habit. Its slightly fibrous condition is the main disadvantage for breeding purposes. However, this may be mitigated if characters happen to be properly combined, in that it is desirable to add strength to some of our present spineless forms of the Indian fig group. Being free from spines, not especially infested with spicules, and able to withstand temperatures of the San Antonio to Austin, Texas, regions without any injury, it is one of the promising forms for increasing hardiness of the more tender spineless stocks. Figure 15 accompanying the text well illustrates the great range of variation in spination of this species.

*OPUNTIA SUBARMATA* Griffiths.

Plant upright to ascending, rather compactly branched, making a shrub 1¼-1½ m. high, and nearly 2 m. in diameter; joints oval, obovate to subcircular, commonly 17-25 cm. in diameter, broadly to narrowly rounded above, glaucous, bluish-green, changing through yellowish to brownish, and finally to gray, scaly; areoles elliptical to ovate or subcircular, 3-6 mm. in longest diameter, 3½-4½ cm. apart, tawny, changing to dirty gray or black, enlarging but slightly with age; spicules yellow, about 2 mm. in length, never formidable, numerous, nor increasing in length with age; spines none; flowers yellow, developing a faint tinge of red along midribs of petals as day advances, opening at 8:00 a. m., and fully open by 9:00, 7-8 cm. in diameter when fully opened, petals 4 cm. long, filaments white above, greenish below, style white below, very slightly greenish tinged above, stigma large, deep, dark green, 11-parted; fruit purple throughout, bearing light tawny subcircular areoles 1-2 mm. in diameter, having a small central tuft of yellow spicules; seeds flattened, regular, about 4 mm. in diameter, prominently notched at hilum, with marginal callus about ¾ mm. wide.

This species is based upon this spineless form, two collections of which have been made in the type locality, neither one of which has developed any spines under cultivation. Other closely related forms, considered to be of the same species, have been secured in the same locality. They have yellowish bone-like spines an inch or more long, in very varying numbers. The cold resistance of the species is probably somewhat greater than that of *cacanapa*;

and on the whole, it is a more promising species for breeding purposes, for it more closely resembles the best native economic species of Texas in both fiber content and succulence. It was selected some years ago in the region of Devil's River, Texas, where the spiny forms are common enough; but this spineless one is rare. It is found at the base of the limestone cliffs, so abundant in this region. Although rare, I have seen three or four plants which were perfectly spineless. It has been vegetatively propagated at San Antonio and Brownsville, Texas, and Chico, California. At none of these places have any species been developed.

*OPUNTIA ELLISIANA* Griffiths.

Plant spreading, ascending, laxly to compactly branched, 1-1½ m. high, and 1¼-2 m. in spread of branch, depending upon moisture and fertility conditions; joints light, pale, glaucous, green, when young, but yellowish shortly after maturity, broadly obovate, about 20 x 24 cm., slightly elevated at areoles when young; areoles at first almost cottony white, turning gray, and finally black, small, 2-3 mm. in diameter, after leaves have fallen and maturity has approached, made up of a central papillum in which the spicules are produced surrounded by a depressed groove separating it from the outer zone of gray or white wool; leaves long, prominent, circular in sections or slightly flattened, subulate, cuspidate, broadly arched backward, 12-15 mm. in length; spicules light yellow, never prominent, scarcely visible, few and only 1 mm. or less in length, scarcely distinguishable except by feeling from the central papillum of wool in which they are situated; spines entirely absent; flowers deep yellow, changing to orange, reddish when closed, some of the outer perianth segments dull, greenish red in bud, about 6 cm. in diameter when open, filaments and style white, stigma very light greenish yellow, 7-parted; fruit pyriform to hemispherical, deep reddish purple throughout, young ovary thickly beset above with small white subcircular areoles 3 mm. apart, and 1½ mm. in diameter, the wool being prominently raised to 1 mm. or more in a compact columnar tuft, from center of which are produced 1-2 delicate yellowish fugaceous spines, 2-3 mm. long and 1-3 or 4 minute spicules 1 mm. long or less, the lower part of ovary having only 1-3 spicules, and the areoles being much farther apart.

It is thought that all of the material of this species in cultivation today has been grown from stocks secured at Corpus Christi, Texas. The origin is not known, but it has evidently been in cultivation a long time. It is now

quite widely distributed in collections due to the efforts of the Department and Professor J. C. Ellis, who first found it cultivated by Mexicans in the outskirts of Corpus Christi. There are indications that it has been derived by selection from native forms of southern Texas; but the evidence is not conclusive. It is perfectly hardy at Austin, and doubtless is fully as hardy as *Op. cacanapa*, and possibly as hardy as *Op. subarmata*. In growth it is not as good as the other two; but it is much more smooth, approaching if not quite equaling in this respect the smoother forms of the Indian-fig group. Another feature is the few spicules on the fruits. On these accounts, the species is quite promising for breeding purposes.

While these three forms appear to be the most promising, and are the ones upon which the greatest effort is being expended at present, it is not at all impossible that other selections may be made of as great, if not even greater merit. One nearly spineless form recorded under my collection No. 9087, from Webb County, Texas, is a rapid, very succulent, wavy jointed, compact form, as good as any of the above, were it not for its few spines. It is probably very close to, if not the same as, forms of *Opuntia subarmata*, mentioned on another page. Another selection made last year is a remarkably smooth form

of *Op. bentonii*. It is thus far devoid of spines, but has quite prominent spicules. This grows rapidly, but its joints are as thin as those of *Op. cacanapa*.

The difference in cold resistance of these forms is not great. They will withstand from 12 to 20° lower temperatures than the conventional spineless ones of today; and will probably all be hardy throughout the entire pear region of Texas.

#### SUMMARY.

The main problem associated with spineless prickly pear culture today is to increase the resistance of these plants to low temperatures.

Hardy native species of the United States, more particularly of central Texas, are thought to be the most promising source of hardiness.

Three, with a possible additional two, selections have been made from the Texas region which are considered very promising, and which have been successfully crossed with the tender spineless species.

The selections already made have resulted in the production of forms of native hardy species which are entirely devoid of spines, and which remain spineless under cultivation. These forms are also as rapid of growth as the spiny natives of the Texas region.

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#### Bud Selection Fails

Bud selection from high producing and low producing strawberries carried on through twelve years showed absolutely no gain in productiveness by selecting runners from high producing parents, at the Missouri agricultural experiment station.

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#### Raspberry Breeding

In the work of raspberry breeding at the New York State agricultural experiment station (Geneva), it is reported that "two series of crosses involving over 700 seedlings have proved '*Rubus neglectus*' to be a hybrid between *R. strigosus* and *R. occidentalis*. At the same time some very interesting white fruited seedlings have appeared and also a seeming mutation, a dwarf, which appears to indicate from its numbers that certain of our raspberries carry dwarfness as a recessive character. Although the crossing of the named varieties has proved unusually successful, much of the future work with both *Rubus* and *Ribes* will be in hybridizing species. Already some interesting hybrids have been secured between *Ribes nigrum* and *Ribes oxycanthoides*. To further this hybridization work the station is making a collection of species of these two genera."